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Adoption of Big Data Analytical Tools at Higher Education Institutions A Case of Saudi Arabia

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Abstract:
Computer networks are heavily loaded with huge amount of data generated by local and online applications. Big data has been a key concern for the computer networks due to extensive use of computing resources. Modern businesses are considering big data as key concern in terms of data usage and extra cost both for hidden and physical resources. This paper is planned to assess and observe the adoption of big data analytical tools in Higher Education Institutions of Saudi Arabia. Big data analytical tools can deal with huge amount of data patterns for better understanding and use especially in decision making. For this purpose, a questionnaire was prepared in accordance with the relevant literature and distributed through Google Docs to gather the required information. Furthermore, collected data was thoroughly analyzed by applying quantitative measures using PLS-SEM. The study has proven through quantitative analysis that Technological factors like *Complexity* (CPT) *and Compatibility* (CPM), Organizational factors like *Top Management Support* (TMS) *and Organization Readiness* (OR) and Environmental factors *Learning Resources* (LE) *and Operational Effeteness* (OE) are some of important factors for the adoption of big data analytical tools in Higher Education Institutions (HEIs). Adoption of big data analytical tools has also proven that university networks are more stable and less congested. HEIs can better benefit from adoption of big data analytical tools by improving the overall learning process. Machine learning techniques can further enhance and improve the learning environment by deploying an appropriate method of data classification and aggregation. Current research has significantly added to the knowledge base theory through quantitative study outcome. Adoption of big data analytical tools will improve the university network performance and will help to further facilitate the decision making process.

Keywords: Big Data, HEIs, Machine Learning, Technical Analytical Tools etc.

I. INTRODUCTION

In the last few years, computer networks have faced diverse sets of huge amount of network traffic known as big data. High volume of data is generated by local and online applications in business organizations. This is affecting the performance of network resources, especially in business enterprises. Big data concerns have already been recognized by online platforms like Google and Amazon etc. It has also been considered in most businesses like smart cities, agriculture, healthcare, finance, manufacturing industries, transportation and universities. Big data analytical tools are deployed by using machine-learning techniques for organizing and distributing the massive amount of data into meaningful data sets to overcome the big data concerns for helping the business decision-makers. This is study is purely focusing on some of important impact factors in adoption of big data analytical tools in higher education institutions of Saudi Arabia.

Generally, big data is observed as *volume*, *speed*, *diversity*, and *accuracy* (Johnes *et al.*, 2018). Data used for analysis is known as *volume* and data flow speed is known as *velocity*. Furthermore, its type varies between the numbers of received data formats such as both structural with non-structural data (Hwang, 2019). Moreover, reliability of accurate data are the degrees of the accuracy of the data patterns. It further expands the field of big data knowledge for further study and interpretation of data forms so that they can be better-understood and used in business decisions and forecasting (Pratsri and Nilsook, 2020). Data volume is the number of data patterns used for analysis including structured and unstructured data variances over a computer network (Muhammad, Tasmin and Nor Aziati, 2020). However, veracity is the level of data accuracy, precision, and trust. Big data analytical tools further extends by using these data patterns for providing helpful information to the decision-makers to predict the future prospect of the business growth. Fig 1, below gives the detail of four Vs of big data:

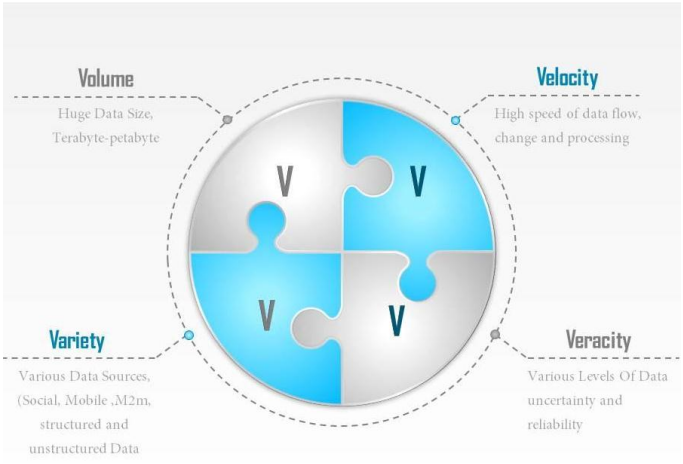


Figure 1: (Four Vs) Volume, Velocity, Variety and Veracity of Big Data (Reza et al., 2017)

Usually, computer networks are highly vulnerable because of the huge volume of data traffic. Higher Education Institutions (HEIs) are also having the same problem and need to be addressed for better use of computing resources. Big data analytical tools are considered very high and recommended by the data experts as one of the primary solutions to overcome this problem. But at the same time adoption of any new technology is not an easy task. There are many concerns that affects negatively and does not grant the full benefits of proposed technology. This research is initially planned to observe and address the importance of big data analytical tools in Higher Education Institutions (HEIs) to identify the key success factors for optimal use of network resources (Alyoussef and Al-Rahmi, 2022). This study will mainly focus on better utilization of university networks by applying big data analytical tools. The study will primarily collect quantitative data from students, teachers, and technical professionals to identify the bottlenecks for the poor response time of local and online applications (Vatsala, Jadhav and R, 2017). Recent studies have proved that big data analytical tools have a strong impact on network performance in different business sectors. Literature provides enough evidence to deploy the big data analytical tools in HEIs to overcome this problem (Alsunaidi *et al.*, 2021). University networks become more vulnerable in terms of dealing with a huge amount of unstructured data (Beerkens, 2022). In this regard, network infrastructure needs to be properly monitored to assess and observe the overall data traffic. Furthermore, quantitative study results conducted in the Higher Education Institutions of Saudi Arabia will be helpful and beneficial for the decision makers.

II. IMPORTANCE OF BIG DATA IN HEIS:

Big data as term has been devised by Drigas and Leliopoulos in 2014 in the domain of computer networks, like mobile networking and cloud computing, where huge amount of data is produced by local and online applications a real time (Al-Rahmi and Alkhalaf, 2021). This data has been marked as unstructured data at large scale and need to arrange a more organized and structure way for better use in the business decision making process. It was also considered high by the rapidly growing business organizations dealing with huge amount of data in the modern world of businesses where IT is an integral part of the businesses (Elmqaddem, 2019). Higher education is an important sector where big data analytical tolls demand is increasing in the recent past. As data is produced at very high rate due to extensive use of both local and online applications by the users. Academic staff have most of activities performed online by using different Learning Management Systems (LMS) to improve and enhance their working capability by discovering modern teaching methods. Similarly, students are using the same in performing different tasks using the university networks. In addition to this, there are many other administrative activities creates extra overhead on university networks, which slows down the network performance. Overall this all affects the network utilization and disrupts the network communication by increasing the computational processing time (Hwang, 2019). Researchers have also considered that adoption of big data analytical tools in HEIs will improve the overall network performance in general and further it will facilitate the business decision makers to use the right data for pursuing the future prospect of the business organization (Mago and Khan, 2021). This has been implemented in university networks by deploying different modern techniques such as big data analytical tools like augmented reality and virtual reality for improving the academic learning process. This process can be further improved by deploying the modern machine learning techniques by categorizing the data as supervised learning, unsupervised learning and re-enforcement learning mechanisms. Supervise learning will create great impact on data collection, classification and organization by performing some regression functions for data analysis. Unsupervised learning will organize the data as multiple classification groups. Re-Enforcement learning will arrange the data by using the best learning method for maximizing the network performance (Mago and Khan, 2021). ML techniques are very much useful in classifying the big data to be arranged and presented for enhancing the decision process.

Furthermore, adoption of big data analytical tools in HEIs is considered very high in terms of bringing innovation in technological framework to enhance the IT expertise of technical professionals at all levels (Poulsen, Hasager and Jensen, 2017). It will also add value to the students in the process of learning by using the modern innovative learning methods (Al-Rahmi and Alkhalaf, 2021). It will also help the academic staff by using variety of assessment methods to measure the student behaviors and attitudes associated with efficacy in the given learning environment c (Hwang, 2019).

III. PROBLEM STATEMENT

Recent past has shown that high volume of network activity is affecting the overall performance of university networks in Higher Education Institutions of Saudi Arabia. This is also affecting the business growth in general and it forces business organizations for overspending to expand the university networks from time to time. This leads to spend more financial resources to upgrade the existing networks. This paper is primarily focusing on the basic impact factors like, technological, organizational and environmental factors to bridge the identified research gap. This study will also look for the mechanism and procedures, which could make the computer networks more stable by saving physical computing resources and lessening the financial expenses. Following are some of the key study objectives to be addressed in the current study:

- To assess and observe the overall impact of big data analytical tools on HEIs.
- To assess and observe the technological factors affecting the HEIs.
- To assess and observe the organizational factors affecting the HEIs.
- To assess and observe the environmental factors affecting the HEIs.

Based on the above mentioned literary facts, below is discussion on relevant supported literature as an evidence for the current study to make the study consistent with the past researches in the same domain.

IV. LITERATURE REVIEW

Big data analytics is a vast domain in terms of deploying the most modern analytical tools in different computing environments. Network traffic has so much importance since high volume data is generated by local and online applications (Undavia, Patel and Patel, 2017). It has become more complex and mostly divided into structured and unstructured nature of data. Granberg stated that more than 80% of business data is produced in the unstructured form and it stored on centralized databases on servers (Granberg, Palm and Palmberg, 2021). This big percentage makes the data management more difficult especially when it comes to take the important and strategic business decisions. In this regards, a well-formed big data definition is given hereunder:

"A revolution that will transform how we live, work and think information in novel ways to produce useful insights or goods and services of significant extract new insights or create new forms" (Mukthar&Sultan, 2017)

Big data analytical tools are a modern technique to arrange the data into usable and unusable data patterns to be used for technical and analytical purposes. In addition to the normal use of computing, HEIs networks are being more congested by the use of online tools like Learning Management Systems (LMS) and other local and online applications like Moodle and Blackboard (Chinsook *et al.*, 2022). Deployment of big data analytical tools in education sector is an important tool to collect and analyze data in real time without putting extra efforts and producing overheads on the main servers (Khan, Khojah and Vivek, 2022). In addition to this, huge volume of data is going beyond the traditional database environments to capture, store, manage and analyze. Which is itself a complex and difficult process to handle the data.

Furthermore, big data analytical tools enables business organizations to enhance the business value by making the business processes more transparent. Big data analytical tools can perform more practical operations for better and more accurate use in business decisions making. Most of recent research studies have pointed out the importance of use of big data analytical tools for data storage and performing to enhance the overall network performance (Khan, Ara Shakil and Alam, 2015). Deployment of big data analytical tools is used to enhance the computer network performance and to help and facilitate the business decision makers (Muhammad *et al.*, 2022).

Most of the recent research considers many aspects of big data analytical tools in different business environments. First most are the high impact factors like technological complexity refers to the design of the concerned technology in terms of its characteristics and use and Technological compatibility refers to the application which fulfills the requirement of the business needs in terms of use of IT resources in assessing and observing the both dependent and independent study variables. These technological factors play an important role in successful adoption of big data analytical tools (Khan, Khojah and Vivek, 2022).

Second is organizational factors like those that top management support refers to the providing a conducive and supportive working environment required for data integration and architecture. In addition to this, organizational readiness of the companies to allocate the financial resources for developing the culture and tradition of adoption of innovative technologies in the business organizations both for internal and external resources required for improving capacity building for the adoption level in business organizations. Organizational factors also important in terms of successful adoption of big data analytical tools in HEIs. (Popovič *et al.*, 2018). Furthermore, some environmental concerns are some of external factors like learning resources and operational effectiveness is also high impact factor adoption of big data analytical tools in higher education institutions (Sekli and De La Vega, 2021).

Lastly, environmental factors like learning resources refers to creating the awareness by learning the more appropriate resources and operational effectiveness refers to developing important and must needed capabilities required for adoption of big data analytical tools in HEIs (Lutfi *et al.*, 2022).

In addition to this, big data analytical tools are very important in most of business domains. It has also been observed that this modern tool for dealing with this problem is arranging and managing the network data by transforming the complex data patterns into better and more clearly understandable data sets for the betterment of business prospects (Alsunaidi *et al.*, 2021). Recent research endorses the importance of big data analytical capabilities. It also shows that big data analytics is one of the best approaches to deal with this critical issue of network instability. This gives a more realistic picture of network communication by collecting different data patterns. This will be used to develop a more comprehensive and well-versed method where big data analytical applications can be better deployed in university networks (Sekli and De La Vega, 2021).

Recent past shown that big data analytical tools are gathering high acceptance in diversified business models of modern era. At the same time, adoption of big data analytical tools is not its best in higher education institutions. This domain still has many areas to be investigated for the better utilization of big data adoption in higher education sector.

V. RESEARCH METHODOLOGY

The current study has adopted a quantitative method for data collection through a survey based detailed questionnaire. Quantitative research is known for performing authentic numerical analysis, hence error margin is also minimum (Bryman, 2006). For sampling cross-sectional survey questionnaire Non-Probability based Convenience Sampling method is used, which is most suitable in the given circumstances (Kothari, 2004). A questionnaire was formed by including the demographic detail of participants regarding education and technical experience. A questionnaire was distributed using Google Docs to students, academic staff, and technical experts from different educational majors. A detailed questionnaire was prepared based on the finding of the literature conducted with three point Likert Scale ranking to look for the ideal and realistic viewpoint from the concerned industry. Likert scale is preferred as being one of the most suitable format used for this kind of studies. This is formed as (*1 = Low Impact, 2 = Moderate Impact, 3 = High Impact* (Zelie, 2021). A total of four questions were formed for demographic detail and eighteen questions to gather

information for the research purpose (Woodrich and Fan, 2017). Around 123 samples were collected by using an online survey by the researcher. After applying the data normalization tools, 94 total responses, out of which 123 responses were found valid and usable for the current study. Electronic mail was also used to collect data from technical professionals and 22 technical professionals were contacted through email to get their valuable input for the benefit of this research.

VI. RESEARCH HYPOTHESIS DEVELOPMENT:

Big data denotes to large amount of structured and unstructured data and needs certain coherent technologies to modern methods for separating the usable and unusable data patterns. This data is produced by both local and online applications in modern computing world. Four Vs are a big source of its description but there are some other aspects also to elaborate the big data credentials. It has also been referred that technological factors have high importance in the endogenous and exogenous study constructors and variables, which are very crucial and critical in adoption of big data analytical tools (Khan, Khojah and Vivek, 2022). There are many concerned success factors like, technological, organizational and environmental factors paly vital role in its adoption of big data analytical tools in businesses (Popovič *et al.*, 2018) (Al-Rahmi and Alkhalaf, 2021).

In this regards, for assessing the technological factors, technological complexity refers to the design of the concerned technology in terms of its characteristics and use, this will assess the use of big data analytical tools in HEIs as it complexity produces the high level of innovation perceived as difficulty in understanding and use of technology (Khan, Khojah and Vivek, 2022). This has been studied and researchers have reported that the level of use can be better if the technology is not hard to use. This hypothesis is used in this study to further enhance the impact of factor of complexity of technology. Furthermore, Technological compatibility refers to the application which fulfills the requirement of the business needs in terms of use of IT resources etc. (Alyoussef and Al-Rahmi, 2022). Literature has shown that compatibility has a significant role in adoption of big data. Hence, H1 and H2 are proposed for the current study:

H1: *Complexity can positively influence the adoption of big data analytical tools in HEIs.*

H2: *Compatibility can positively influence the adoption of big data analytical tools in HEIs.*

For the purpose of assessment and observation of organizational factors, top management support refers to the providing a conducive and supportive working environment, required for data integration and architecture for adoption of big data in HEIs as this is very important factor for a successful adoption (Alyoussef and Al-Rahmi, 2022). In addition to this, organizational readiness is the domain where companies will allocate sufficient finances for developing a suitable business environment to adopt the modern and innovative technologies like big data analytical tools. This will assess and observe the expertise of the business organizations to promote and deploy the big data analytical tools in the modern world of business (Muhammad *et al.*, 2022). Current literature supports this argument being an important criterion for big data adoption in HEIs. Hence, H3 and H4 are proposed for the study:

H3: *Top management support can positively influence the adoption of big data analytical tools in HEIs.*

H4: *Organizational readiness can positively influence the adoption of big data analytical tools in HEIs.*

Environmental factors also play an important role in adoption of big data analytical tools in HEIs. Environmental concerns are some of external factors like learning resources and operational effectiveness is also high impact factor adoption of big data analytical tools in higher education institutions (Beerkens, 2022) (Sekli and De La Vega, 2021). It can create and enhance the awareness among peers and can play an important role in their success in terms of tracking the student activities and use of resources (Muhammad *et al.*, 2022). In addition to his business organizations the development of necessary capabilities for the best implementation of big data analytical tools in HEIs. H5 and H5 are proposed for the study:

H5: *Learning Resources can positively influence the adoption of big data analytical tools in HEIs.*

H6: *Organizational effectiveness can positively influence the adoption of big data analytical tools in HEIs.*

VII. PROPOSED STUDY MODEL

Furthermore, to address the above mentioned hypothetical questions, there is enough literature evidence for further research particularly in higher education institutions. To address the research questions and research objectives following is the proposed study model and the main study variables for the current research study detailed in the table 1 given below:

Table 1: Detail of variables for the study

Constructors/Variables		Literature Evidence
Adoption of Big Data Analytical Tools		
Technological Factors	*Complexity (CPT)*	(Al-Rahmi and Alkhalaf, 2021)(Beerkens, 2022)(Sekli and De La Vega, 2021)
	Compatibility (CPM)	
Organizational Factors	*Top Management Support (TMS)*	(Sekli and De La Vega, 2021)(Maroufkhani, Iranmanesh and Ghobakhloo, 2022)(Al-Rahmi and Alkhalaf, 2021)
	Organizational Readiness (OR)	
Environmental Factors	*Learning Experience (LE)*	(Muhammad *et al.*, 2022)(Sekli and De La Vega, 2021)(Chong and Lim, 2022)
	Operational Effectiveness (OE)	

Above mentioned study, variables have been thoroughly studied for developing a conceptual study model for the current research. This is in light of the relevant literature reviewed and supported by the research evidence. Model will be used assess and observe the overall impact of big data analytical tools at

Higher Education Institutions (HEIs). Research model has one dependent variable *Adoption of Big Data Analytical Tools* and three independent factors, like Technological Factors, Organizational Factors and Environmental Factors. Furthermore, for evaluating the Technological Factors for assessing and observing the *Complexity* at H1 and *Compatibility* at H2. In addition to this, Organizational Factors for assessing and observing the *Top Management Support* at H3 and *Organizational Readiness* at H4. Lastly, Environmental Factors for assessing and observing to evaluate the *Learning Experience* at H5 and *Operational Effectiveness* at H6 for the adoption of big data analytical tools in HEIs. The proposed model is depicted hereunder in Fig. 2 given below:

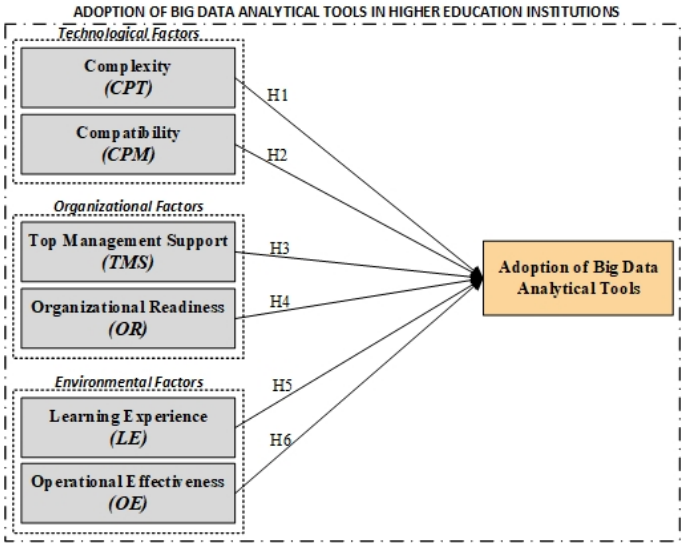


Figure 2: Study model proposed for the research

VIII. RESULT AND ANALYSIS:

This particular study was planned to observe the current level of adoption of big data analytical tools in higher education institutions of Saudi Arabia. For the purpose of data collection, a detail survey based questionnaire was prepared and distributed by using the Google docs. Electronic mail was also used as a tool to reach to the technical professionals for collecting their valuable viewpoint. Data sampling validity was also performed for making data more usable and consistent for the study outcome. In addition to this data, normalization was also performed to make the data more valid and reliable. For the purpose of statistical analysis, SPSS was used as a tool for performing different statistical analysis required for the current study.

In regards to analyze the data Partial Least Square (PLS) and Structural Equation Modeling (SEM) was chosen to considered for the current study. As this has been authentic and dependable tool for testing the hypothetical models in social and behavioral sciences (Worthington and Whittaker, 2006). PLS-SEM known for a strong technique for measuring and evaluating the causal associations in this kind of study. This has been deployed to assess and estimate the statistical measures for item based reliability, internal consistency reliability, convergent validity and discriminant validity (Sagoe, 2012). Following are some statistical analysis performed for the current study:

i. Convergent & Discriminant Validity Analysis:

Convergent validity analysis is used to measure the proposed study items following the benchmark of the method adopted for the study In addition, during the examination, item loadings were statistically found to be highly significant, as shown in table 2. Discriminant validity is performed in an analysis where study items can be different amongst dissimilar and to cater to the overlapping concerns between the study constructs. In view of the data experts, Fornell and Larcker‘s (1981) method has been preferred and opted to perform measurement analysis (Ghadi *et al.*, 2012a). Furthermore, the table below states that CPT has 0.85, CPM has 0.86, TMS has 0.87, OR has 0.87, LE has 0.79 and OE has 0.78. These scores are well between the specified ranges as prescribed by professionals illustrated in the table 2:

Table 2: Convergent & Discriminant Validity Analysis

Constructors/ Variables		Technological Factors		Organi-zational Factors		Environmental Factors	
		CPT	CPM	TMS	OR	LE	OE
Technological Factors	*CPT*	**0.85**					
	CPM	0.27	**0.86**				
Organizational Factors	*TMS*	*0.04*	0.37	**0.87**			
	OR	*0.33*	0.25	0.03	**0.87**		
Environmental Factors	*LE*	*0.07*	0.37	-0.33	0.22	**0.79**	
	OE	*0.08*	0.18	-0.05	0.34	-0.35	**0.78**

ii. Composite Reliability Coefficient:

It is a measurement method of internal consistency in research items, much like Cronbach's alpha (Netemeyer, R. G., W. O. Bearden, 2003). Experts have stated that convergent validity measures the group of variables converging in the study model. It depicts the degree to which study items are weighted in a correlation (Hair *et al.*, 2014).

For the purpose of analysis, it is important to mention that the benchmark for the given criterion must be adhered in accordance with the recommended statistical measurement standards. In regards to this, AVE should be in range of more than 0.50 and less than 0.70, whereas the benchmark ranges for Cronbach’s must be within the range of more than 0.70 and item loadings should be less than 0.60. Furthermore, true statistical variances in the data analysis in contrast to the relatively total scale must be adhered as per the bench mark (Brunner, 2005). Study results for the paper observed and assured that AVE, CR and Cronbach’s are well within the prescribed range of the statistical measures. Fronell and Larcker’s introduced this method in 1981 where the square root AVE in performing data analysis is replaced with diagonal study values in the given relational matrix while measuring the CR. Finally, Cronbach’s is the statistical measure for the best data assessment during the data analysis (Ghadi *et al.*, 2012b).

In this regards, the item loadings for each study variables are well within the specified score/scale of AVE, CR and

Cronbach is as recommended by the professionals. Hence, the statistical measures applied for the current study can be recommended and used to enhance the adoption of big data analytical tools at HEIs. This is also supported by the literature evidence from the current studies as supported by the current study results as shown in the table 3 below:

Table 3: Composite Reliability Coefficient

Constructors/ Variables		Loadings	AVE	CR	Cron-bach's α
Technological Factors	*Complexity (CPT)*	**0.7388**	0.5743	0.8245	0.8261
	Compatibility (CPM)	**0.7476**			
Organizational Factors	*Top Management Support (TMS)*	**0.7483**	0.5344	0.7543	0.7073
	Organizational Readiness (OR)	**0.7762**			
Environmental Factors	*Learning Experience (LE)*	**0.7484**	0.5441	0.7532	0.7062
	Operational Effectiveness (OE)	**0.7809**			

iii. Structural Model Significance:

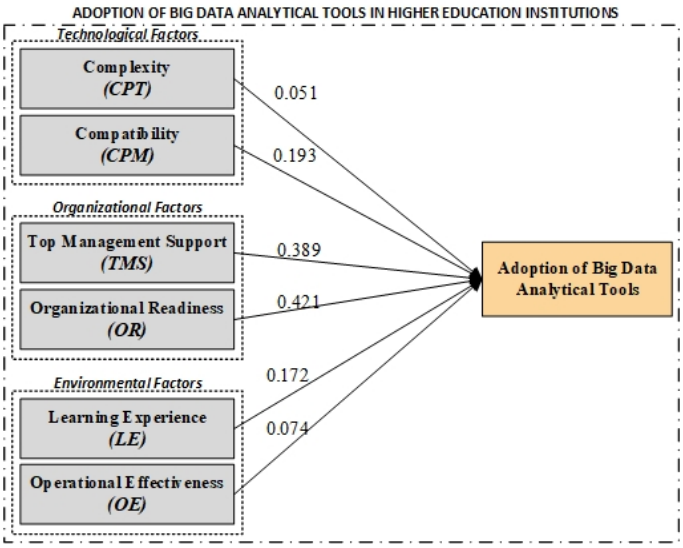
This particular model significance is an important tool for measuring AVE, and the benchmark is 0.50 and above (Hair *et al.*, 2014). A cross-loading method was used to establish the discriminant validity to ensure that all the indicators are measured accurately for the current study. Furthermore, Smart PLS 3 was used to determine the path coefficient's statistical significance by using the bootstrapping method. The performed analysis showed the statistical significance of proving the t-values and p-values of each path coefficient during the study. Values given for t-Values and p-Values are within the specified range/score of low, moderate and high values as recommended by the professionals. Further detail of the coefficients produced is presented in the following table 4.

Table 4: Significance of the Structural Model

Hypothesis	t-Values	p-Values	Decision
H1	2.813	0.051	***Low***
H2	2.832	0.193	***Moderate***
H3	5.887	0.389	***High***
H4	5.779	0.421	***High***
H5	2.512	0.172	***Moderate***
H6	2.542	0.074	***Low***

iv. Hypothesis Test Results:

As per the data analysis for the study aligned with the study objectives and scope, data analysis results shows three kind of impact *Low*, *Moderate* and High respectively in the given range. Technological factors (Complexity (PT) value 0.051 showing *Low* whereas Compatibility (CPM) value 0.193 are showing *Moderate* impact level on adoption of big data analytical tools in HIEs. However, Organizational factors (Top Management Support (TMS) value 0.389 and Organizational Readiness (OR) value 0.421 are showing *High* impact level on adoption of big data analytical tools in HIEs. Lastly, Environmental factors (Learning Experience (LE) value 0.172 showing *Moderate* whereas Operational Effectiveness (OE) value 0.074 are showing Low impact level on adoption of big data analytical tools in HIEs. Further details is shown in path t-Values as illustrated in the figure below in Fig. 3:



Figur 3. Hypothesis Testing Results for the Study

v. Effect Sizes:

In this regards, Cohen's f^2 is a quantitative measure of the strength to assess that at what level an independent variable affects a particular dependent variable's R^2. In multiple regressions these effects can be considered Weak/Low from 0.02 to 0.15, Medium/Moderate from 0.15 to 0.35 and high bench mark is above 0.35 (Zabukovsek and Bobek, 2013).

In accordance with the prescribed benchmark values for assessing the effect size, study results shows that Technological Factors, Complexity (0.024) having *Low* and Complexity (0.364) having *Moderate* level of influence in adoption of big data analytics in HEIs. Secondly, Organizational Factors, *Top Management Support* (0.261) and *Organizational Readiness* (0.272) having *High* level of influence in adoption of big data analytics in HEIs. Lastly Environmental Factors, *Learning Experience* (0.352) having *Moderate* and *Operational Effectiveness* (0.028) having *Low* level of influence the adoption of big data analytics in HEIs. Further detail is illustrated in the table 5:

Table 5: Effect Size Details

Constructors/ Variables		Techno-logical Factors	Organi-zational Factors	Environ-mental Factors
Technological Factors	*Complexity (CPT)*	0.024		
	Compatibility (CPM)	0.364		
Organizational Factors	*Top Management Support (TMS)*		0.261	
	Organizational Readiness (OR)		0.272	
Environmental Factors	*Learning Experience (LE)*			0.352
	Operational Effectiveness (OE)			0.028

This research papers has given the detail the overall quantifiable numeric analysis of this study based on the questionnaire distributed. Main purpose of this section is to get better understanding of the quantitative analysis as performed using SPSS.

Discussion and Conclusion:

Literature has proved that there is big margin of adoption of big data analytical tools in Higher Education Institutions of Saudi Arabia. This is first needed to observe and analyze the university networks and secondly it is needed to improve and modernize the overall learning system in HEIs. Higher Education institutions are playing a vital part in growth of country's infrastructural base upon which the future growth is based as stated in the VISION 2030 of Saudi Arabia. This particular study aimed on the core concern of adoption of big data analytical tools for evaluating the current situation of computer network in Saudi higher education sector and to improve the overall learning environment by deploying the most modern and innovative standards. For this purpose, a comprehensive causal study framework based on the recent literature was formed for the current study. Study focused on basic research questions to first assess and observe the overall impact of big data analytical tools on HEIs regarding technological factors (Complexity and Compatibility), organizational factors (Top Management Support and Organization Readiness) and regarding the environmental factors (Learning Experience and Operational Effectiveness) influencing the HEIs in adoption of big data analytical tools. Furthermore, these questions were divided into sixteen causal questions to get the real viewpoint of the participants. Questionnaire was distributed to stakeholder's of public and private universities and found a comparatively good response. Results were analyzed by using PLS-SEM and found that study has contributed significantly for helping and facilitating the decision makers at the HEIs. Quantitative results have proven that study has contributed from *Minor* to *Moderate* to *High* level of impact on the proposed research item. Questions were asked to get participant's valuable inputs adoption of big data analytical tools at HEIs in Saudi Arabia. This study has contributed in terms of body of knowledge by addressing the core problem reported in the literature review. Study has tried to address all the concerned stakeholders of HEIs to get their input and analyze it for better assessment and result oriented outcome. Researcher found that for the better adoption and implementation of big data analytical tools, there must be a transparency among different academic processes at different levels, which could hinder and affect the study outcome. This could be addressed to avoid in future furthering strengthening the study outcome. Study could further focus on the HEIs structure by adding the more diversified factors to further enhance and improve the overall results.

References:

[1] Al-Rahmi, W.M. and Alkhalaf, S. (2021) 'An empirical investigation of adoption Big Data in higher education sustainability', *Entrepreneurship and Sustainability Issues*, 9(2), pp. 108–122. doi:10.9770/jesi.2021.9.2(7).

[2] Alsunaidi, S.J. *et al.* (2021) 'Applications of big data analytics to control covid-19 pandemic', *Sensors*, 21(7). doi:10.3390/s21072282.

[3] Alyoussef, I.Y. and Al-Rahmi, W.M. (2022) 'Big data analytics adoption via lenses of Technology Acceptance Model: empirical study of higher education', *Entrepreneurship and Sustainability Issues*, 9(3), pp. 399–413. doi:10.9770/jesi.2022.9.3(24).

[4] Beerkens, M. (2022) 'An evolution of performance data in higher education governance: a path towards a "big data" era?', *Quality in Higher Education*, 28(1), pp. 29–49. doi:10.1080/13538322.2021.1951451.

[5] Brunner, G. (2005) 'Brunner, G.: Supercritical fluids: technology and application to food processing. Journal of Food Engineering 67, 21-33', *Journal of Food Engineering-J FOOD ENG*, 67, p. 2004.

[6] Bryman, A. (2006) 'Integrating quantitative and qualitative research: How is it done?', *Qualitative Research*, 6(1), pp. 97–113. doi:10.1177/1468794106058877.

[7] Chinsook, K. *et al.* (2022) 'Big Data in Higher Education for Student Behavior Analytics (Big Data-HE-SBA System Architecture)', *Higher Education Studies*, 12(1), p. 105. doi:10.5539/hes.v12n1p105.

[8] Chong, L.Y.Q. and Lim, T.S. (2022) 'Pull and Push Factors of Data Analytics Adoption and Its Mediating Role on Operational Performance', *Sustainability (Switzerland)*, 14(12). doi:10.3390/su14127316.

[9] Elmqaddem, N. (2019) 'Augmented Reality and Virtual Reality in education. Myth or reality?', *International Journal of Emerging Technologies in Learning*, 14(3), pp. 234–242. doi:10.3991/ijet.v14i03.9289.

[10] Ghadi, I. *et al.* (2012a) 'Construct Validity Examination of Critical Thinking Dispositions for Undergraduate Students in University Putra Malaysia', *Higher*

Education Studies, 2(2), pp. 138–145. doi:10.5539/hes.v2n2p138.

[11] Ghadi, I. *et al.* (2012b) 'Construct Validity Examination of Critical Thinking Dispositions for Undergraduate Students in University Putra Malaysia', *Higher Education Studies*, 2(2). doi:10.5539/hes.v2n2p138.

[12] Granberg, C., Palm, T. and Palmberg, B. (2021) 'A case study of a formative assessment practice and the effects on students' self-regulated learning', *Studies in Educational Evaluation*, 68(August 2020). doi:10.1016/j.stueduc.2020.100955.

[13] Hair, J.F. *et al.* (2014) 'Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research', *European Business Review*, 26(2), pp. 106–121. doi:10.1108/EBR-10-2013-0128.

[14] Hwang, Y. (2019) 'Adoption of Big Data in Higher Education for Better Institutional Effectiveness', *American Journal of Creative Education*, 2(1), pp. 31–44. doi:10.20448/815.21.31.44.

[15] Johnes, G. *et al.* (2018) 'Data analytics and decision making in education: towards the educational data scientist as a key actor in schools and higher education institutions', *Handbook of Contemporary Education Economics*, pp. 184–210. doi:10.4337/9781785369070.00014.

[16] Khan, M.A., Khojah, M. and Vivek (2022) 'Artificial Intelligence and Big Data: The Advent of New Pedagogy in the Adaptive E-Learning System in the Higher Educational Institutions of Saudi Arabia', *Education Research International*, 2022, pp. 1–10. doi:10.1155/2022/1263555.

[17] Khan, S., Ara Shakil, K. and Alam, M. (2015) 'Cloud Based Big Data Analytics: A Survey of Current Research and Future Directions CLOUD-BASED BIG DATA ANALYTICS-A SURVEY OF CURRENT RESEARCH AND FUTURE DIRECTIONS', (September). Available at: https://www.researchgate.net/publication/281144737.

[18] Kothari, C.R. (2004) *Research Methodology: Methods & Techniques*, *New Age International (P) Ltd*. doi:10.1017/CBO9781107415324.004.

[19] Liao, Y.K. *et al.* (2022) 'The Integration of the Technology Acceptance Model and Value-Based Adoption Model to Study the Adoption of E-Learning: The Moderating Role of e-WOM', *Sustainability (Switzerland)*, 14(2). doi:10.3390/su14020815.

[20] Lutfi, A. *et al.* (2022) 'Factors Influencing the Adoption of Big Data Analytics in the Digital Transformation Era: Case Study of Jordanian SMEs', *Sustainability (Switzerland)*, 14(3), pp. 1–17. doi:10.3390/su14031802.

[21] Mago, B. and Khan, N. (2021) 'A Proposed Framework for Big Data Analytics in Higher Education', *International Journal of Advanced Computer Science and Applications*, 12(7), pp. 685–691. doi:10.14569/IJACSA.2021.0120778.

[22] Maroufkhani, P., Iranmanesh, M. and Ghobakhloo, M. (2022) 'Determinants of big data analytics adoption in small and medium-sized enterprises (SMEs)', *Industrial Management and Data Systems* [Preprint], (February). doi:10.1108/IMDS-11-2021-0695.

[23] Muhammad, N. *et al.* (2022) 'Achieving operational excellence through the lens of lean and Six Sigma during the COVID-19 pandemic', *International Journal of Logistics Management*, 33(3), pp. 818–835. doi:10.1108/IJLM-06-2021-0343.

[24] Muhammad, R.N., Tasmin, R. and Nor Aziati, A.H. (2020) 'Sustainable Competitive Advantage of Big Data Analytics in Higher Education Sector: An Overview', *Journal of Physics: Conference Series*, 1529(4). doi:10.1088/1742-6596/1529/4/042100.

[25] Mukthar&Sultan (2017) 'Big Data Analytics for Higher Education in Saudi Arabia', *Researchgate*, 15(September), pp. 256–277.

[26] Netemeyer, R. G., W. O. Bearden, et al. (2003) 'Scaling Procedures: Issues and Applications. London, Sage.', (January), p. 2003.

[27] Popovič, A. *et al.* (2018) 'The impact of big data analytics on firms' high value business performance', *Information Systems Frontiers*, 20(2), pp. 209–222. doi:10.1007/s10796-016-9720-4.

[28] Poulsen, T., Hasager, C.B. and Jensen, C.M. (2017) 'The role of logistics in practical levelized cost of energy reduction implementation and government sponsored cost reduction studies: Day and night in offshorewind operations and maintenance logistics', *Energies*, 10(4). doi:10.3390/en10040464.

[29] Pratsri, S. and Nilsook, P. (2020) 'Design on Big data Platform-based in Higher Education Institute', *Higher Education Studies*, 10(4), p. 36. doi:10.5539/hes.v10n4p36.

[30] Reza, M. *et al.* (2017) 'Network Traffic Classification using Machine Learning Techniques over Software Defined Networks', *International Journal of Advanced Computer Science and Applications*, 8(7), pp. 220–225. doi:10.14569/ijacsa.2017.080729.

[31] Sagoe, D. (2012) 'Precincts and prospects in the use of focus groups in social and behavioral science research', *Qualitative Report*, 17(15), pp. 1–16. doi:10.46743/2160-3715/2012.1784.

[32] Sekli, G.F.M. and De La Vega, I. (2021) 'Adoption of big data analytics and its impact on organizational performance in higher education mediated by knowledge management', *Journal of Open Innovation: Technology, Market, and Complexity*, 7(4). doi:10.3390/joitmc7040221.

[33] Undavia, J.N., Patel, S. and Patel, A. (2017) 'Future trends and scopes of Big Data Analytics in the field of Education', *International Journal of Engineering and Technology*, 9(3S), pp. 9–14. doi:10.21817/ijet/2017/v9i3/170903s002.

[34] Vatsala, V., Jadhav, R. and R, S. (2017) 'A Review of Big Data Analytics in Sector of Higher Education', *International Journal of Engineering Research and Applications*, 07(06), pp. 25–32. doi:10.9790/9622-0706022532.

[35] Woodrich, M. and Fan, Y. (2017) 'Google Docs as a tool for collaborative writing in the middle school classroom', *Journal of Information Technology*

Education: Research, 16, pp. 391–410. doi:10.28945/3870.

[36] Worthington, R.L. and Whittaker, T.A. (2006) 'Scale Development Research: A Content Analysis and Recommendations for Best Practices', *The Counseling Psychologist*, 34(6), pp. 806–838. doi:10.1177/0011000006288127.

[37] Zabukovsek, S.S. and Bobek, S. (2013) 'TAM-based external factors related to ERP solutions acceptance in organizations', *International Journal of Information Systems and Project Manageme nt*, 1(4), pp. 25–38. doi:10.12821/ijispm010402.

[38] Zelie, E.M. (2021) 'The Effect of Internal Control Components on Mitigating the Impact of COVID-19 Risks in Healthcare Organizations in Ethiopia', *Journal of Economics, Business, & Accountancy Ventura*, 23(3). doi:10.14414/jebav.v23i3.2517.